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Experimental Investigation of Partial Replacement of Sand by Laterite Soil in Concrete

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Abstract*: The attention of most researchers is shifting towards the optimization of building materials by using local contents; the use of indigenous materials; and local industrial by-products unique and abundant in certain localities. Concrete were made with laterite soil taken from different sources replacing the conventional fine aggregate (local river sand) in steps of 5% up to 20%. Their compressive strengths and split tensile strength determined to check for conformity with concrete as with a view of small scale to determine the acceptable percentage 0%, 5%,10%,15%, & 20% replacement. Laterized concrete structures have potentially sufficient strength compared with that of normal concrete. Soil tests were performed on the laterite soil samples to characterize the soils. Classification of the lateritic soil samples within Mailam, revealed that the lateritic soils are mostly sandy clay of high plasticity and may replace sand by up to 20%, though an approximate linear decrease in strength with increasing sand replacement with lateritic soil was observed. In the compressive strength test, cube -30 numbers of 150 mmx150 mm, split tensile strength test cylinder -30 numbers laterite concrete sizes were produced and crushed with the under compressive machine to determine their twenty-eight day compressive strength of specimens. The process of selecting suitable ingredients of concrete and determining their relative amounts with an objective of producing a concrete of required strength as economically as possible is termed as concrete mix design. The Mix Design for concrete M25 grade is being done as per the Indian Standard Code IS: 10262-2009.
Keywords— ***Fine Aggregate, Laterite Soil, Compressive Strength, Split Tensile Strength, Workability.***

I. INTRODUCTION

High cost of building materials has been the bane of construction industry in the developing countries of the world as a result of importation of most of the building materials. Laterite soil possesses other advantages which makes it potentially a very good and appropriate material for construction, especially for the construction of rural structures in the developing countries. This study is specifically focused on the effects of replacement of the conventional fine aggregate (sand) with lateritic soils found in Ota on the compressive strengths of concrete. Laterite soil possesses other advantages which makes it potentially a very good and appropriate material for construction, especially for the construction of rural structures in the developing countries.

Lasisi and Ogunjimi, (1984) These merits include little or no specialized skilled labour required for laterized concrete production and for its use in other construction works; and laterized concrete structures have potentially sufficient strength compared with that of normal concrete. From an engineering point of view, laterite or lateritic soil is a product with red, reddish brown and dark brown colour, with or without nodules, ability to self-harden, concretions, and generally (but not exclusively) found below hardened ferruginous crusts or hard plan (Ola, 1983). Lasisi and Ogunjide (1984) assert that the degree of laterization is estimated by the silica sesquioxides ratio ($SiO_2/(Fe_2O_3 + Al_2O_3)$). Silica-Sesquioxide (S-S) ratio less than 1.33 are indicative of laterites, those between 1.33 and 2.00 are lateritic soils and those greater than 2.00 are non-lateritic types. Studies are currently going on in the use of lateritic soil in concrete production where laterite is made to partly or wholly replace conventional fine aggregate in the production of concrete known as laterized concrete; and in the production of concrete units such as Compressed Laterized concrete (CLC) usually stabilized with cement. Presently, these applications are mostly limited to buildings in rural areas and low income housing projects which are mostly situated at satellite areas (outskirts) of Central Business Areas (CBA's).

II. MATERIALS

A. Cement

Ordinary Portland cement (OPC 43 grade) is used as the main binder conforms to IS: 8112 -1991 were used. The physical properties of cement obtained and used are given in Table 1

Table 1: Physical properties of 43 grade OPC

Sl.no	Properties	Values
1	Fineness	5%
2	Initial setting time	30 mines
3	Final setting time	600 mines
4	Standard consistency	29%
5	Specific gravity	3.1

B. Fine Aggregate

For the present investigation, fine aggregate tested as per IS: 383-1970. In the present investigation fine aggregate is natural sand from local market is used. The physical properties of fine aggregate like specific gravity, gradation and fineness modulus are tested in accordance with IS: 383-1970

Table 2: Physical properties of Fine Aggregate

Sl.no	Properties	Values
1	Size	Passing through 4.75mm
2	Fineness Modulus	3.225
3	Water Absorption	3.7%
5	Specific gravity	2.71

C. Coarse Aggregate

The crushed coarse aggregate of 20 mm maximum size rounded obtained from the local crushing plant. The physical properties of coarse aggregate are tested in accordance with IS; 383-1970.

Table 3: Physical properties of Coarse Aggregate

Sl.no	Properties	Values
1	Size	20mm
2	Water Absorption	1.56%
3	Specific gravity	2.79

D. Laterite soil

This study investigates the suitability of laterite soil as fine aggregate in place of sand, and specifically seeks to determine whether laterized concrete would satisfy the minimum compressive strength requirement of BS 8110 (1997) for use in reinforced concrete works, which is 25 N/mm2.

Table 4: Physical properties of Laterite Soil

Sl.no	Properties	Values
1	Size	Passing through 4.75mm
2	Fineness Modulus	3.225
3	Water Absorption	8.84%
4	Specific gravity	2.6

Figure 1 Laterite soil

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III. METHODOLOGY

Concrete were made with laterite soil taken from different sources replacing the conventional fine aggregate (local river sand) in steps of 5% up to 20%. Their compressive strengths and split tensile strength determined to check for conformity with concrete as with a view of small scale to determine the acceptable percentage 0%, 5%,10%,15%, & 20% replacement. Laterized concrete structures have potentially sufficient strength compared with that of normal concrete. To cast concrete cubes specimen of size 100× 100 ×100 and to test the harden cube on 28 days under compression. To cast concrete cylinder specimen of size 150× 300 and to test the harden cylinder on 28 days under split tensile.. The collection of material for the laterite concrete such and for M25 concrete mixes were collected and casted. The conventional concrete was cured in water. The tests on conventional and laterite concrete specimens were conducted 7dyas and 28days. The result were analyzed and discussed with comparisons of the two types of concrete and their properties.

IV. RESULT AND DISCUSSIONS

A. Compressive Strength

Table 5 Compressive strength for cubes

Sl.no	Replacement %	7 days compressive strength	28 days compressive strength
1	0%	21.77	31.11
2	5%	20.14	26.62
3	10%	20.22	28.14
4	15%	21.59	30.37
5	20%	19.20	28.88

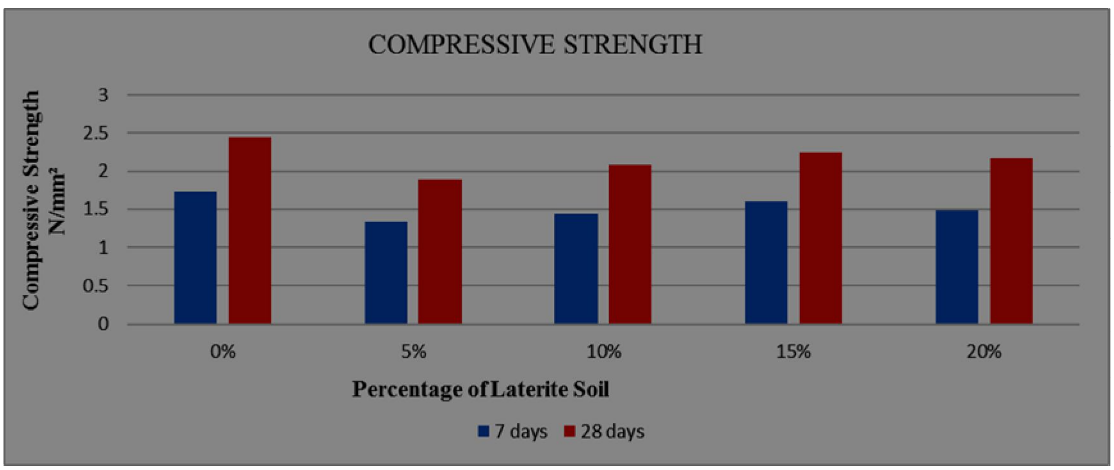

Figure 2 Compressive strength for cubes

B. Split Tensile Strength

Table 6: Split Tensile Strength

Sl.no	Replacement %	7 days (N/mm^2)	28 days (N/mm^2)
1	0%	1.72	2.45
2	5%	1.34	1.88
3	10%	1.43	2.07
4	15%	1.60	2.24
5	20%	1.48	2.17

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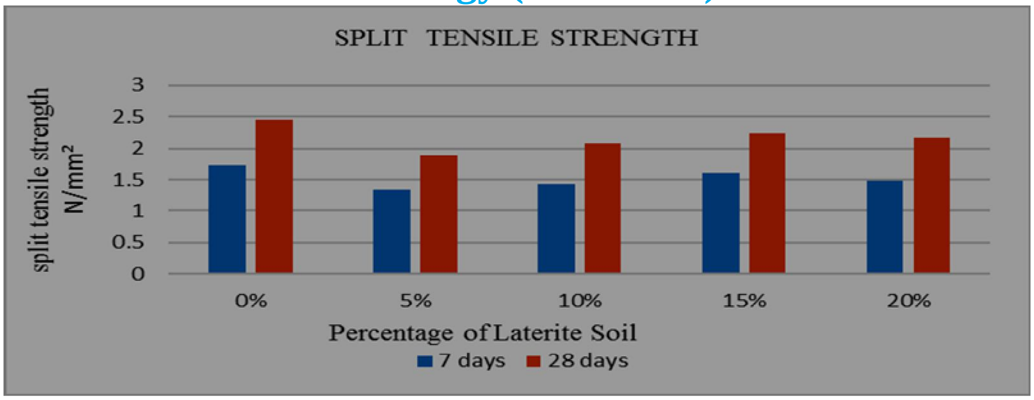

Figure 3. Split Tensile Strength

V. CONCLUSION

From the above given compressive and split tensile strength values, we calculated that 15% is the optimum value. The presence of coarse grained good quality-laterite in the making of concrete would maximum 5% to20% partial replacement of laterite soil using the construction work.

VI. FURTHER STUDIES

The future studies and research right based on the characteristics and properties of laterite soil along with sand as partial replacement for different grades

In the same manner, the research on laterized concrete can be continued with the following aim.

To get optimized mix proportioning for high strength laterized concrete by Indian standard methods.

To get laterized concrete for grade beyond 40 Mpa.

To get the economical and eco-friendly laterized concrete by satisfying all the durability conditions.

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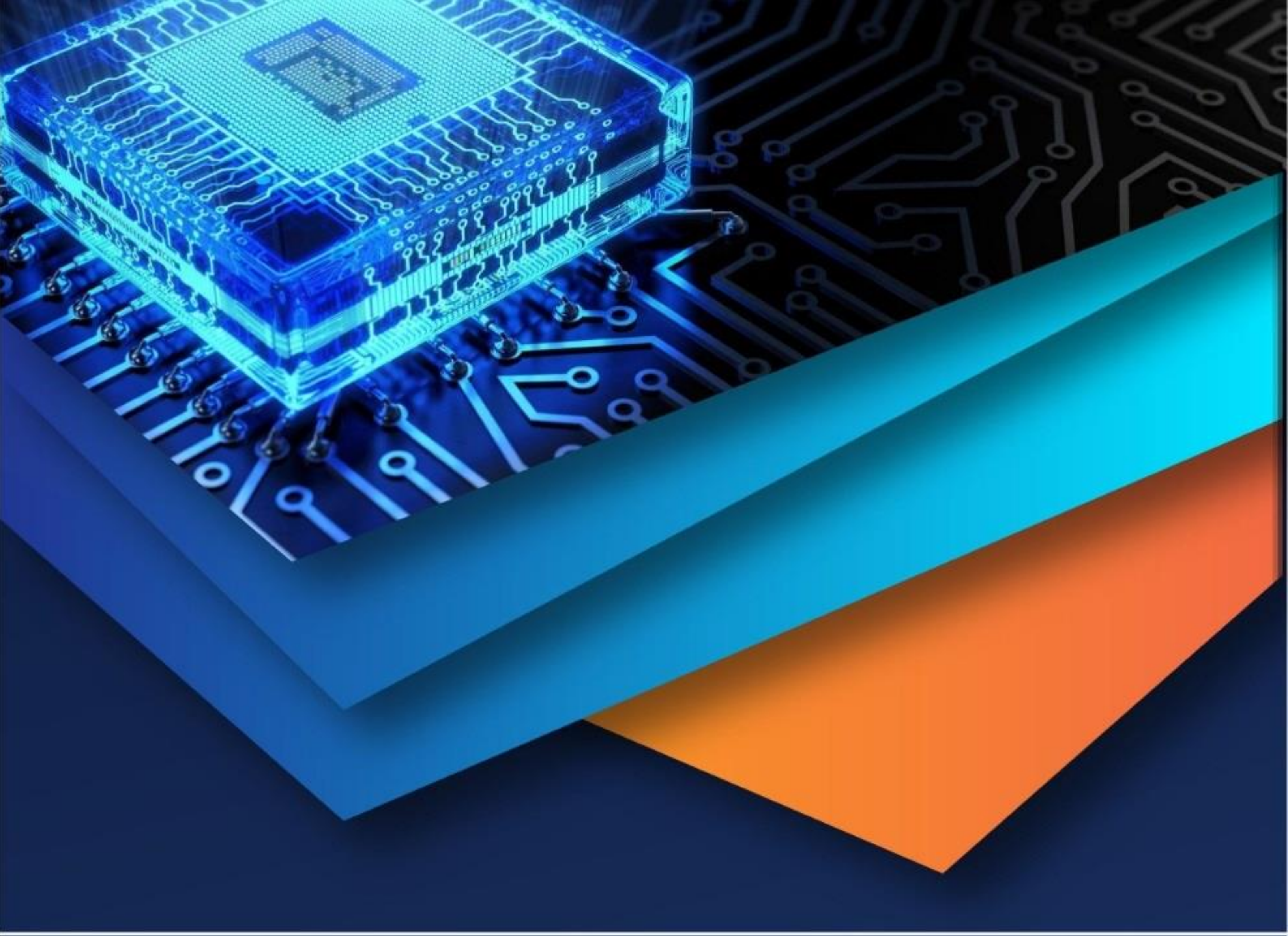

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